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### Scientific Note

## DIGGER WASPS (HYMENOPTERA: SPHECIDAE) AND ROBBER FLIES (DIPTERA: ASILIDAE) AS PREDATORS OF GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE) ON MONTANA RANGELAND

Digger wasps and robber flies have been reported to take short-horned grasshoppers as prey, with some predators apparently specialized upon Acrididae (Rees, N. E. 1973. USDA-ARS Tech. Bull. 1460). While conducting research on grasshoppers and robber flies during the summers of 1987–1993, I obtained 56 records of three species of digger wasps and five species of robber flies preying on grasshoppers at three sites in SW Montana. These records are reported here, along with brief descriptions of nesting behavior of the wasps.

I made all observations at three locations: 1) Madison River Site (MRS)—14 km south of Three Forks, Gallatin County, Montana (45°45' N, 111°35' W), 2) Dead Cow Pasture (DCP)—5 km south of Three Forks, 3) Horseshoe Hills (HH)—6 km NE of Logan, Gallatin County Montana. All three sites were grassland, with the predominant grasses at MRS and HH being *Stipa comata* Trinius & Ruprecht and *Bouteloua gracilis* (Humboldt et al.) Lagasca y Segura ex. Steudal. At DCP, these grasses had been replaced by crested wheatgrass, *Agropyron cristatum* (L.) Gaertner and alfalfa, *Medicago sativa* L. as part of a range management program in the 1960s. Prey records are listed by species, where possible, with the nymphal stage (i.e., instar in roman numerals) or adult sex given in parentheses.

North American species of the sphecid genus *Prionyx* prey solely upon acridid grasshoppers and, except for one species, place their prey within shallow unicellular nests (Evans, H. E. 1958. Ann. Entomol. Soc. Amer., 51: 177–186). The prey I collected from nests of seven *Prionyx atratus* (Lepelletier) females included four grasshopper species, *Aulocara elliotti* Thomas (2 f), *Melanoplus packardii* Scudder (2 f), *Melanoplus sanguinipes* (Fabr.) (2 f), and *Trachyrachis kiowa* Thomas (f). All were collected at MRS, except the two *M. sanguinipes* which were collected at DCP.

Female behavior and nest structure of this species were similar to that described by Evans for *P. atratus*. While digging nests, the females stored their already paralyzed prey in clumps of grass, 1–2 m from the nests. All prey were placed head inward into horizontal cells 2.5 to 4.0 cm long and 2.5 to 4.5 cm deep at the center. The burrow leading to the cell was 3 to 8 cm in length and set at an angle of 30 to 45° to the soil surface. I found eggs on three prey; two were laid on the basal portion of the right hind femur and one was attached to the right side of the thorax just posterior to the mesothoracic leg. A small larva on one of the eggs may have been a miltogrammine fly (Diptera: Sarcophagidae), an adult of which was seen entering a nest on one occasion. In a fourth nest, excavated two days after it was provisioned, a small wasp larva was feeding near the right hind coxal cavity. After provisioning a single cell with a single prey, nests were immediately closed by the females packing soil into the burrow.

I also observed nesting females of other unidentified *Prionyx* that may have been one or both of the species with red abdomens that I have collected at the same sites: *P. canadensis* (Provancher) and *P. parkeri* Bohart and Menke. As with *P. atratus*, these three females dug shallow unicellular nests that they stocked with a single prey on which an egg was deposited on the right hind femur. I observed two of the prey being stored within clumps of nearby vegetation while the wasps were constructing their nests. The two prey collected at MRS were *Ageneotettix deorum* (Scudder) (f) and *T. kiowa* (f); at DCP the female provisioned the nest with an *A. ellioti* (f). I also observed three *Tachytes* sp. females carrying acridid prey of the species *A. deorum* (V at MRS) and *M. sanguinipes* (V at DCP and V at MRS).

I observed robber flies of four genera feeding on 12 species of Acrididae. The prey of *Efferia staminea* (Williston) at MRS included: *Aeropedellus clavatus* (Thomas) (1 V), *Arphia conspersa* Scudder (1 II), *Aulocara ellioti* (1 II, 1 IV), *M. packardii* (1 II), *M. sanguinipes* (1 II, 3 III, 3 IV), *Melanoplus* sp. (1 IV), *Phliobostroma quadrimaculatum* (Thomas) (4 IV), and *Psoloessa delicatula* Scudder (1 I, 2 II). At HH, this species preyed upon *M. femurrubrum* (DeGeer) (1 IV), *P. quadrimaculatum* (2 IV), and *P. delicatula* (1 I). Grasshoppers comprised 2% of 1074 prey that I observed for this species from 1987 to 1992. Similarly, in a previous study of this species, Acrididae made up 4% of all prey (Lavigne, R. J. & F. R. Holland. 1969. Univ. Wyo. Agric. Expt. Sta. Sci. Monogr. No. 18). Such low values are not surprising for a predator that takes prey from a wide variety of insect taxa (O'Neill, K. M. 1992. Can. J. Zool. 70: 1546–1552).

Two other species of *Efferia*, *E. bicaudata* (Hine) and *E. frewingi* (Wilcox), also occurred at MRS, but, because females are difficult to distinguish, the prey records for this species are combined. Although *P. delicatula* (4 II, 2 III) was the most common prey, I observed the *Efferia* preying upon *A. deorum* (m) and *P. quadrimaculatum* (1 V, 1 m). At MRS, I observed the asilid *Machimus occidentalis* (Hine) preying upon *M. sanguinipes* (II) and *P. quadrimaculatum* (II); these comprised 1.7% of 120 prey (unpublished data).

The robber fly *Scleropogon coyote* (Bromely) was relatively rare and inconspicuous at the study sites, but like *Stenopogon picticornis* (Loew) (Lavigne, R. J. & F. R. Holland. 1969) and *Proctacanthus milbertii* MacQuart (Joern, A. & N. T. Rudd. 1982. Oecologia 55: 42–46), it preyed primarily on late instar and adult grasshoppers (10 of 15 prey records). At MRS, I observed this species taking *A.*

*elliotti* (m), *P. quadrimaculatum* (1 m), *P. nebrascensis* (Thomas) (V), and *T. kiowa* (3 m). At DCP they preyed upon *A. clavatus* (f) and *A. deorum* (f), and at HH upon *A. deorum* (f) and *Melanoplus gladstoni* Scudder (IV). The other prey taken by this species included two conspecifics, one *Megaphorus willistoni* (Williston) (Asilidae), one sarcophagid fly, and one crambine moth (Pyralidae). *Scleropogon coyote* prey selection did not strongly overlap that of the other predators. Unlike the *Efferia* and *Machimus*, whose prey were 94% nymphs, 80% of the prey of *S. coyote* were adults ( $n = 10$ ). In addition, six of eight of the adult prey of *S. coyote* were males, while all 11 of *Prionyx* prey were females.

Although robber flies have some potential for significant impact on grasshopper populations (Joern & Rudd 1982), many robber flies also prey on natural enemies of acridids, thus potentially counterbalancing any positive economic impact (Rees, N. E. & J. A. Onsager. 1985. Environ. Entomol., 4: 20–23). At the study sites, I observed robber flies preying on species of Sarcophagidae, Bombyliidae, Asilidae, and Sphecidae that are known to attack grasshoppers. Furthermore, most asilids readily switch prey preferences as the local abundance of potential prey changes (O'Neill 1992). The sphecid species discussed here may be more specialized upon acridids, but their impact on grasshopper populations will be difficult to measure because their prey choice and activities are more difficult to observe than those of asilids.

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### Scientific Note

## THE IDENTITIES OF *ANAGRUS* (HYMENOPTERA: MYMARIDAE) EGG PARASITOIDS OF THE GRAPE AND BLACKBERRY LEAFHOPPERS (HOMOPTERA: CICADELLIDAE) IN CALIFORNIA

The grape leafhopper, *Erythroneura elegantula* Osborn, is an important pest of grape vineyards in California's Central Valley. Eggs of *E. elegantula* were reported to be attacked by *Anagrus epos* Girault (Hymenoptera: Mymaridae) and this parasitoid was believed to overwinter in eggs of *Dikrella* sp. (Homoptera: Cicadellidae) on blackberry (Doutt, R. L. & J. Nakata. 1965. J. Econ. Entomol., 58: